THE ROLE OF OIL AND GAS MAJORS IN THE TRANSITION TOWARDS A CIRCULAR ECONOMY

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Abstract: Current economies rely on oil and gas industries given their need for fossil fuel energy sources. For a transition towards a more circular economy (CE), fuelled by renewable energy with non-renewable resources circulating in closed loop, oil and gas companies can support the CE transition by implementing circular measures regarding waste management and treatment, as well as investing in low carbon and renewable energy technologies. This paper aims at identifying strategies and measures undertaken by oil and gas companies, which could support the CE transition. Case studies of two oil and gas majors analyse strategic, financial and environmental data. Results show that both corporations increasingly invest in alternative energy technologies such as solar, biofuels, wind and hydrogen. However, upstream oil and gas production and downstream sales of oil products remain their core revenue streams. Several projects and initiatives have been identified as supporting the CE transition. Further research could focus on quantifying the actual contribution of those projects to a CE, their environment impacts and their financial prospects.

Index terms: Oil and gas, corporate strategy, circular economy, energy management, decarbonisation

I. INTRODUCTION

Despite growing awareness on climate change and growing integration of renewable energy technologies, oil and gas continue to be main sources of world energy. In 2018, oil and gas represents 34% and 24% of world primary energy consumption respectively [1]. In addition, primary energy consumption of oil and gas has increased by 13% and 28% respectively between 2008 and 2018. Although the share of renewables (wind, geothermal, solar, biomass and waste) only represents 4% of the mix in 2018, it has increased by 4.5 times since 2008 [1].

The oil and gas industry has a key role to enhance the sustainability of economic development. Since the end of the 20th century, corporate actors had to redefine their strategy in line with sustainable development, as a result of operational criticism due to environmental accidents caused by oil and gas operations [2]. In addition, the goals of the Paris Agreement of the 21st Conference of the Parties (COP21) in 2015 require efforts from policy-makers, academia, but also industries. According to the Carbon Major Database, the fossil fuel industry and its products accounted for 91% of global industrial greenhouse gas (GHG) emissions in 2015 and 70% of all cumulative anthropogenic GHG emissions [3]. More than half of global industrial GHG emissions can be traced to 25 corporate and state producers [3]. Oil and gas companies need to redefine their strategy in line with the Paris Agreement.

To address sustainability issues, including resource depletion, waste accumulation and ecosystem degradation, the Circular Economy (CE) model has been proposed and defined as an "industrial system that is restorative or regenerative by intention and design" [4]. " It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models" [5].

To support the CE transition and adopt CE principles, companies must adapt their strategy and business model. To achieve circular resource flows, business models can redesigned following three fundamental strategies [6]: (1) closing resource loops through recycling, reusing, remanufacturing or recovering, (2) slowing resource loops through design of long life goods and product life extension, and (3) narrowing resource loops through resource efficiency. A fourth strategy can be considered: (4) dematerialising resource loops through e.g. the development of a service economy [7].

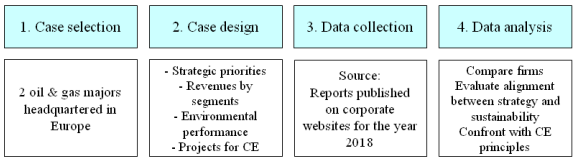
Although there is significant research on the fossil fuel industry and sustainability [2], [8], [9], the oil and gas industry has rarely been studied with the perspective of the CE. Circular strategies for oil and gas exploitation in China have been identified, in the areas of technical progress and innovation, resource efficiency and supporting policies and markets [10]. Strategies and investments in renewable energy by oil and gas majors have also been investigated [11]. The study concluded that Shell, Total, BP have embarked on the transition from oil companies to energy companies, while ExxonMobil and Chevron remain hydrocarbon focused companies.

The paper aims at investigating the strategies of oil and gas companies and their practices and projects that can support the CE. It analyses the business models, financial revenues, environmental indicators and targets, as well as CE-related projects undertaken by two oil and gas majors. Section II explains the research approach and method used in the paper. Section III presents the results of the case studies analysis. Section IV concludes and proposes future challenges and research prospects.

II. METHODS

The article aims at exploring two research questions: (1) what is the strategy of oil and gas companies and their approach to sustainability, (2) how can they contribute to the CE? Therefore, a case study approach has been selected given the exploratory nature of the research, the fact that the researcher has little control over events, and the problem being contemporary, real-life and involving various variables [12]–[14]. The research process can be represented as in Figure 1, with the following steps: case selection, case design, data collection and data analysis.

Figure 1: Research Process



First, companies selected had to meet the following criteria: (1) active in oil and gas operations, (2) headquartered in Europe, (3) representing large market shares, (4) in the private sector (not state-owned). Shell and Total have been selected.

Table 1
Largest Public Companies in Oil and Gas Operations from Forbes 2000 List (2018 ranking of largest public companies)

Company	HQ	Status	Market value
ExxonMobil	U.S.	Private	$343.4 B
Shell	Netherlands	Private	$264.9 B
Chevron	U.S.	Private	$228.3 B
PetroChina	China	State-owned	$198.7 B
BP	U.K.	Private	$149.5 B
Total	France	Private	$149.5 B
Sinopec	China	State-owned	$126.4 B

Data are extracted from reports published on corporate websites: Total Integrated Report 2018 [15], Total Climate Report 2018 [16], Shell Annual Report 2018 [17], and Shell Sustainability Report 2018 [18]. Extracted data are analysed in a comparative perspective by confronting three perspectives: (1) the information reported by both firms, (2) the alignment between strategic priorities and sustainability commitments, (3) the potential in supporting the CE transition.

The analysis focuses on 4 main aspects. First the strategic priorities as expressed in corporate reports are analysed. Second, financial data are assessed with the objective of comparing the evolution of revenues by business segment. Third, environmental performance is assessed based on indicators and targets related to air emissions, and waste. Finally, projects that could support the CE transition are identified and evaluated against the principles of the CE model.

III. CASE STUDIES

This section presents the results of the case study analysis. Table 2 shows key data regarding the companies. Shell is larger in terms of market value, sales, net income and assets. Regarding Environmental, Social and Governance ratings, such as MSCI, SAM or CDP, Total is rated with slightly higher scores.

Table 2
Presentation of Total and Shell

	Shell	Total
Employees	81 000 employees	104 460 employees
Revenue 2018	$ 388 379 millions	$ 209 363 millions
Net income 2018	$ 23 906 millions	$ 11 550 millions
Assets 2018	$ 399 194 millions	$ 256 762 millions
MSCI ESG Rating	A (average)	A (average)
SAM ESG Score	66	72
CDP Climate	B (management)	A- (leadership)

III. 1. Corporate strategy

Regarding the general business model and strategy of both companies, one can observe similarities. They are active on upstream oil and gas exploration and production, as well as downstream oil products and chemicals. Their activities cover the integrated oil and gas value chain. In addition, they both develop a segment supporting the "energy transition" and providing "cleaner energy solutions":

- Shell: The New Energies business focuses on new fuels for transport, such as advanced biofuels, hydrogen and charging for battery-electric vehicles, and power, such as wind and solar. This is done through acquisitions of companies such as Greenlots (US) for electric vehicles charging, or interests in wind and solar power projects.

- Total: The Gas, Renewables and Power segment develops low carbon electricity through subsidiaries such as SunPower (US) for solar and Quadran (France) for solar, wind biogas and hydroelectricity. In addition, Total invests in the market of energy efficiency services, for example through the acquisition of GreenFlex (France), which provides consultancy and data intelligence services.

III. 2. Revenues by segment

When looking at revenues and earnings by segment, revenues from renewable energy and power are not presented in a separate category, but rather combined with gas activities. Figures 2 and 3 present the earnings by segment of Shell and Total.

Figure 2: Shell - Earnings by segment

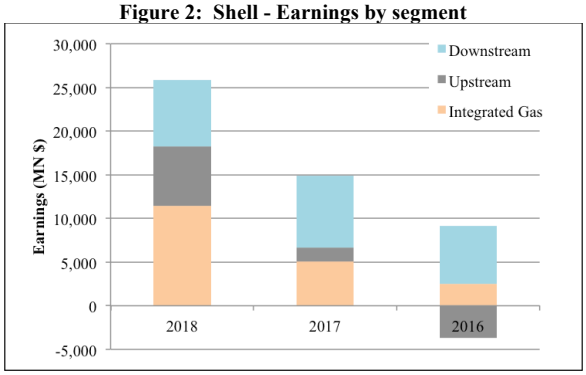
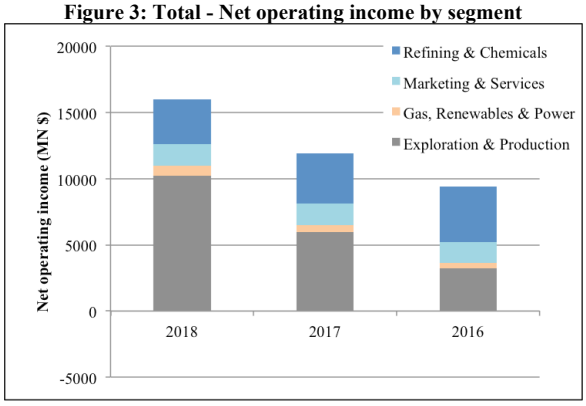


Figure 3: Total - Net operating income by segment



For Total, Income from exploration and production of oil and gas represents 64% of 2018 total operating income and has increased more than 3 times since 2016. The gas, renewable and power segment only represents 5% of 2018 and has increased by 72%. Europe, Central Asia, the Middle Ease and Africa are the regions from which originate 87% of 2018 revenues from oil and gas production, as well as where the growth in revenues has increased the most.

For Shell, Earnings come from Integrated Gas (47%), Downstream (31%) and Upstream (28%). They increased the most in the Integrated gas segment (by 353% between 2016 and 2018. Revenues from oil and gas production (from third parties) have increased in the most in North and South America between 2016 and 2018.

III. 3. Environmental performance and targets

Information on GHG emissions, emissions impacting air quality, and waste have been analysed. It should be noted that this part of the analysis does not aim at comparing environmental performance of companies. Despite the availability of large amount of sustainability-related data and the existence of sustainability frameworks, comparability between reports is limited, even for companies operating in the same industry. This has been highlighted by a study that evaluated the intra-industry comparability of sustainability reports of oil and gas companies [19].

Both companies report on their GHG emissions by following the GHG Protocol. No clear deceasing trend in total direct GHG emissions can be observed since 2015. The GHG emissions associated with the life cycle of energy products, from production to end use, is referred to as “net carbon footprint” by Shell and “carbon intensity” by Total.

Table 3
GHG emissions and carbon footprint of energy products

	2018	2017	2016
Shell			
Direct GHG emissions (Mtons CO2 eq)	71	73	70
Net carbon footprint of energy products (gCO2 eq/Mj)	79	79	79
Total			
Direct GHG emissions (Mtons CO2 eq)	42	41	45
Carbon intensity of energy products (g CO2 eq/kBtu)	71	73	74

In addition, both companies claim to support and contribute to the Paris Agreement. Shell aims to reduce the carbon footprint of their energy products (direct emissions associated with production + indirect emissions associated with customers’ use) by 20% in 2035 and 50% in 2050. Total set the targets of 15% reduction in direct greenhouse gas (GHG) emissions between 2015 and 2025 and 15% reduction in carbon intensity of energy products used by customers between 2015 and 2030.

Other air emissions are reported, such as sulphur oxides (SOx), nitrogen oxides (NOx) and volatile organic compounds. Shell’s report did not present any target, while Total set the target of decreasing SO2 air emissions by 50% between 2010 and 2020. In addition, both companies are part of the Zero Routine Flaring Initiative and aim at eliminating routine flaring by 2030.

Regarding waste, both companies claim to increase efforts to reduce waste generated and to reuse or recycle materials. Waste is reported differently by both firms: Shell reports the quantity of waste quantity according to whether it is hazardous or non-hazardous, while Total reports waste percentage by type of treatment process (recycling and/or valorisation, landfill, incineration). Total sets the target of valorising more than 50% of the waste produced by the sites operated by the Group and exceeded the target in 2018: 57% of waste produced

by sites was recycled or valorised. Shell's report does not present any waste target, but mentions that 6 downstream manufacturing sites sent more than 50% of their waste for recycling or reuse in 2018, with 3 of them more than 80%.

III. 4. Circular Economy-related projects

The term "Circular Economy" is mentioned in Shell's Sustainability Report and Total's Annual Report. Initiatives or projects have been identified as potentially supporting the CE transition by closing, narrowing or slowing the resource loop. The analysis identified identified 25 CE-related projects, 14 for Shell, 7 for Total, and 4 where both Total and Shell are involved. They consist of implemented and on-going projects, as well as planned projects. Many of them are developed in partnerships with other stakeholders. Areas of those projects include plastic waste reduction, waste management practices, battery recycling, carbon capture and storage (CCS), as well as alternative energy sources, such as waste-to-energy, biofuels, hydrogen.

Partnerships or consortia are formed for the development of various technologies. For example, Total is part of the consortium BioTFuel to develop lignocellulose. Shell is part of a consortium led by the Port of Los Angeles to develop hydrogen truck refuelling stations, of which one will produce hydrogen from renewable biogas. Shell is member part of COGEN Europe, which is the European Association for the Promotion of Cogeneration.

Projects for **alternative fuels** made from biogenic sources or waste sources are being developed. For example, Shell India completed the construction of a demonstration plant that features a process converting agricultural waste into transport fuel. Shell has a biomethane plant in the US that transforms organic waste into renewable natural gas through anaerobic digestion. Another example is the transformation by Total's La Mède factory into a biorefinery that produces biofuels from vegetable oil.

Regarding **plastic waste**, both majors are founding members of the Alliance to End Plastic Waste. Members include companies concerned with plastic production and consumption. They commit to invest in infrastructure, innovation, education and clean up in order to reduce and eliminate plastic waste. Moreover, Total reports on plastic waste projects, such as the acquisition of Synova in 2019 that produces polypropylene from recycled material, as well as a partnership to develop an industrial polystyrene recycling value chain by 2020. Total Chemicals segments of Shell and Total are partners of the program CleanSweep, which aims at avoiding losses of plastic pellets during handling operations and their dissemination into aquatic environments.

Decommissioning energy production facilities also requires circular measures. The number of decommissioning projects for oil and gas rig and fossil fuel plants is expected to increase [21], [22], along with waste streams resulting from such projects. Both Shell and Total conduct remediation operations and land rehabilitation in line with relevant legislation. Shell cited its largest decommissioning project as example: the Brent oil and gas field in the North Sea. It expects to recycle more than 97% of materials.

Finally, if CO2 is considered as an industrial waste, then **carbon capture and storage** (CCS) can be considered as a useful waste management technique. CCS is developed in the oil and gas industry. For example, Shell and Total, along with Equinor are involved in a project to capture and store industrial CO2 in Norway. However, technologies such as **carbon capture and utilization** (CCU) could comply closer with CE principles [20]. Total and Shell are involved in a strategic partnership with OGCI Climate Investments, BP, Eni, Equinor, Occidental Petroleum to develop a Carbon Capture Utilisation and Storage project in Teesside, England.

Regarding **corporate commitments** towards the CE, Total's report includes 5 commitments: (1) Limit the production of waste and favor its valorisation, (2) Develop polymers that contain up to 50% recycled plastic – conclusive tests carried out on the 3 main types of polymer, (3) Install solar panels on 5000 service stations – 880 service stations with solar panels by the end of 2018, (4) Improve by an average of 1% per year the energy efficiency of the Group's operated industrial facilities, and (5) Incorporate a criterion dedicated to the CE in the Company's purchases. No specific or commitment has been found in Shell's report, although the intention to develop technologies valorising plastics after consumer use.

The projects have been analysed in relation to the 3 fundamental CE strategies explained in Section 1: **closing, narrowing and slowing resource loops**. Most identified projects contribute to closing loops by developing waste recycling techniques and energy production from waste sources. Projects or measures slowing the loop through the design longer-life products or product life extension have not been identified, except Shell Foundation providing support to start-up Aceleron, which reuses waste batteries as low-cost storage in the off-grid sector. Narrowing the loop is an indirect consequence of many projects and measures, as they ultimately enable to consume less primary resources per product or output.

IV. CONCLUSION

The oil and gas industry plays a key role in the global economy. Therefore, it can also play a key role in the development of a more sustainable and circular economy. Oil and gas companies face increasing pressure to reduce environmental impacts and greenhouse gas emissions. In addition, they are exposed to competition and market risks such as fluctuating prices of crude oil, oil products and natural gas. The adoption of CE principles in their operations and strategy can help them improving economic and environmental sustainability.

This paper aims at integrating the CE concept in the oil and gas sector. It investigates the case of two oil and gas majors and analyses their strategy, revenue streams, environmental indicators and targets, as well as projects and initiatives that could facilitate the CE. Findings show that although case companies consider the low carbon transition as one strategic priority, the investment level and revenues generated from low carbon business activities is not reported. Most of their revenues come from upstream and downstream oil and gas segments. Regarding environmental aspects, indicators for air emissions and waste do not enable to compare the environmental performance between companies. Both companies are part of initiatives such as the Zero Routine Flaring by 2030 and the Alliance Plastic Waste. Total's report contains targets and thresholds for sulphur oxides emissions, waste valorisation, energy efficiency and direct GHG emissions. Regarding the CE concept, Total and Shell are involved in a number of projects developing notably waste collection and recycling, waste-to-fuel conversion technologies, carbon capture and storage, hydrogen fuelling stations, and biofuels from vegetable sources. Those projects are often undertaken in partnerships with other organisations or through acquisitions of existing companies.

Further research could focus on evaluating and quantifying the contribution of identified projects to the development of a CE. Project-level circularity indicators could be developed. In addition, the comparability of corporate reports should be enhanced through for instance proposing an industry-specific standardised framework. Finally, an in-depth longitudinal analysis of revenues, income and investments by business segment would enable to better understand the strategic directions of major players of the energy industry.

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